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Efficacy of biostimulants on morphology, flowering and yield of chrysanthemum (*Dendranthema grandiflora*) cv. Kolar local under fan and pad greenhouse

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Abstract
This study was conducted to determine the effect of biostimulants on growth, flowering and yield of Chrysanthemum cv. Kolar local with thirteen treatments such as two concentrations of biostimulants sprayed at four frequencies (first, second, third and fourth spray at 30, 60, 90 and 120 days after transplanting) and untreated control. Each treatment was replicated thrice in randomized complete block design (RCBD). The parameters such as plant height (cm), number of leaves, leaf area (cm^2), stem girth (mm), number of primary branches, number of secondary branches and intermodal length were checked as morphological parameters. Moreover, days taken for first flowering, days to 50% flowering and duration of flowering are the checked flowering parameters whereas number of flowers per plant, flower yield per plant, flower yield per m^2, flower yield per hectare and sucker yield per plant are the yield parameters. Among the different treatments, Spic cytozyme@ 0.4% (T_8) registered maximum plant height (89.04 cm) and intermodal length(2.44 cm), whereas biovita @ 0.6% recorded the maximum number of leaves (143.43), leaf area per plant, (5245.33cm^2), stem girth (8.18 mm), number of primary (11.47) and secondary branches (24.98). Regarding the flowering parameters; among different treatments, minimum number of days to first flower initiation (100.00) and 50 percent flowering (112.33) and maximum flower duration (65.82) was recorded with Biovita @ 0.6%(T_4). However, control (T_{13}) recorded minimum.

Keywords: Biostimulants; chrysanthemum; RCBD; biovita

1. Introduction

Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) is one of the most interesting and oldest flower crops which belongs to the family Asteraceae with a diploid chromosome number of 2n = 36. It is a leading commercial flower crop grown for cut flowers, loose flowers and pot plant. It is popularly known as 'Queen of East', 'Autumn Queen', 'Mums' and "Guldaudi' and it is most popular flower crop of commercial importance. Chrysanthemum as a short-day plant, naturally flowers in the autumn and winter. The flowers are suitable for various purposes like bedding plant, vase decorations, garland making and for garden display (Mridubhashini *et al*.,) [1]. The major limitations in conventional agriculture are the decline in natural resources and environmental damage inflicted by current agricultural practices. Due to the impact of green revolution, in the recent decades, flower growing practices have been evolving towards organic, sustainable or eco-friendly approaches. Therefore, in modern floriculture new insights have been developed to achieve sufficient and sustainable yield with quality blooms. One among such approaches is the use of "Biostimulants" (Wezel *et al*.,) [2]. Plant bio-stimulant is referred as "any substance or microorganism, in the form in which it is, applied to plants, seeds or the root environment with the intention to stimulate natural processes of plants benefiting nutrient use efficiency, tolerance to abiotic stress, regardless of its nutrients content, or any combination of such substances and/or microorganisms intended for this use" (Traon *et al*.,) [3]. Biostimulants have been emerged as a supplement to mineral fertilizers and hold a promise to improve the yield as well as quality of the crop under protected condition (Harshavardhan *et al*., 2016) [3]. The use of humic acid (HA) and sea weed extract is a promising natural resource to be utilized as an alternative for increasing crop production. Keeping in view, the need and importance of biostimulants the present

Investigation was undertaken with an objective to study the effect of Biostimulants on morphology, flowering and yield of Chrysanthemum under fan and pad greenhouse.

2. Material and methods

The study was carried out in fan and pad system of greenhouse at the Department of Horticulture, College of Agriculture, Shivamogga, University of Agricultural and Horticultural Sciences, Shivamogga. During 2017-18.Beds were prepared by digging of soil three times to a depth of 40 cm. The soil was sterilized thoroughly with four percent formalin and covered with black polyethylene film to remain airtight for 48 hours. Then film was removed and the soil was aerated for 24 hours. Later the sterilized field was thoroughly irrigated to drain out the chemical residue. Raised beds of 45 cm height with 1.0 m width were prepared with walking space of 0.5 m between the beds. Rooted terminal cuttings of the variety Kolar Local planted in the raised beds under fan and pad greenhouse with a spacing of 30 × 30 cm. The experiment was laid out in randomized complete block design with three replication and thirteen treatments, T_1-Humic acid 0.5%, T_2-Humic acid 0.6%, T_3-Biovita-0.5%,T_4-Biovita 0.6%, T_5-Recharge 0.5%, T_6-Recharge 0.6%, T_7- Spic cytozyme 0.2%, T_8-Spic cytozyme 0.4%, T_9-Vipul 0.2%, T_{10}-Vipul 0.4%, T_{11}-Boron 0.1%, T_{12}-Boron 0.2% and T_{13}-Control. Spraying of biostimulants was done at 30, 60, 90 and 120 days after transplanting (DAT). Observations recorded systematically at monthly interval and analyzed as per the standard procedure.

3. Results and discussion

The data pertaining to morphological parameters are presented in Table 1. Among the different treatment spic cytozyme at 0.4 percent recorded the maximum plant height (89.04 cm) and intermodal length (2.44 cm). It might be due to the plasticity of the cell wall and energy-rich phosphates are formed ultimately leading to cell division and cell elongation. Another possible explanation for better plant height and internodal length might be due to increased uptake of nutrients and osmotic uptake of water under the influence of biostimulants and in turn, improving nutrient metabolism of plant system. These findings corroborates the results reported by Kadam *et al.*[5] in China aster, Khandelwal *et al*., [6] in marigold and Patra *et al*., [7] in gerbera. Biovita at the rate of 0.6 percent recorded the maximum number of leaves per plant, number of primary and secondary branches, stem girth and leaf area of the plant. Whereas, it was minimum in control. It was clear from the above results that the seaweed extract has increased the number of leaves per plant, Stem girth and number of its branches in comparison with the control. This is attributed to the composition of the seaweed extract such as natural growth hormones (auxins and cytokinins) that promote plant growth via increasing the number of metabolic events such as cell division and enlargement which in turn leading to increase the number of leaves. Also, the extract contains a considerable amount of macro and micro elements which play an important role in the activation of many enzymes and coenzymes which are involved in several biological processes leading to cell division and enlargement. These results are supported by the findings of Poincelot [8] in cosmos, Dhutraj [9] in gaillardia and Violeta *et al*., [10] in chrysanthemum.

A perusal of data on flowering parameters is presented in Table 2. Among different treatments, Minimum number of days to first flower (100), 50 percent flowering (112.33) and maximum flower duration (65.82) was recorded with Biovita @ 0.6 percent (T_4). However, control (T_{13}) recorded minimum. It might be due to the early production of florigen and other flower inducing substances in Biovita treated plants. These results are corroborated with the findings of Shinde *et al.,)* [11] in Marigold.

The data with respect to yield parameters are presented in Table 3.Biovita at 0.6 percent gave significantly more flower yield per plant (511.93 g), per square meter (5.63 kg), per hectare (56.30 t) and sucker yield per plant (9.99). *Ascophyllum nodosum* extracts also contain low levels of cytokinins and auxins as well as moderate levels of other growth stimulants and nutrients. These compounds have been shown to positively affect the growth of plant shoot and root tissue and have been reported to stimulate the growth and yield of plants. Seaweed extract also contains essential elements especially nitrogen and phosphorous in which is responsible for maximum shoot growth, number of branches and hence the ultimate size of the plant resulting in the production of higher photosynthesis, which subsequently led to desirable C: N ratio. These favourable situations led to the production of more number of flowers and ultimately higher yield. The above results are supported by Pruthvi *et al.,)* [12] in chrysanthemum.

Table 1: Effect of biostimulants on morphological parameters of chrysanthemum cv. Kolar local under fan and pad greenhouse

Treatments	Plant height (cm)	No. of leaves per plant	Stem girth (mm)	No. of primary branches	No. of secondary branches	Intermodal length (mm)	Leaf area (cm^2)
T_1-Humic Acid@0.5%	79.98	102.20	5.97	9.00	21.21	1.90	5153.67
T_2-Humic Acida@0.6%	82.9	102.87	6.47	8.41	22.03	1.96	5168.00
T_3-Biovita@0.5%	83.58	135.66	7.93	10.03	23.46	2.02	5188.33
T_4-Biovita@0.6%	84.84	143.43	8.18	11.47	24.98	2.06	5245.33
T_5-Recharge@0.5%	73.52	103.00	6.15	8.86	20.20	1.63	3172.67
T_6-Recharge@0.6%	74.07	108.52	6.92	9.62	20.53	1.67	3249.33
T_7-Spic cytozyme@0.2%	86.91	87.43	4.29	5.56	17.37	2.33	3256.33
T_8-Spic cytozyme@0.4%	89.04	88.87	4.52	5.73	17.97	2.44	3520.00
T_9-Vipul@0.2%	71.45	83.87	5.56	7.00	18.09	1.57	2675.33
T_{10}-Vipul@0.4%	73.96	89.20	5.66	7.80	18.50	1.59	2920.33
T_{11}-Boron@0.1%	73.32	94.27	4.89	6.87	19.17	1.32	2650.33
T_{12}-Boron@0.2%	75.03	78.76	5.10	7.00	19.5	1.37	2815.33
T_{13}-Control	62.24	71.65	3.52	4.65	16.67	1.20	2569.33
SEm ±	2.26	2.95	0.25	0.65	0.61	0.08	111.44
CD @ 0.05	6.60	8.60	0.72	1.90	1.78	0.22	325.26

Table 2: Effect of biostimulants on flowering parameters of chrysanthemum cv. Kolar local under fan and pad greenhouse

Treatments	Days taken for first flowering	Days taken for 50% flowering	Duration of flowering (days)
T_1-Humic Acid@0.5%	112.49	127.32	56.12
T_2-Humic Acida@0.6%	111.00	125.98	60.27
T_3-Biovita@0.5%	103.39	116.16	63.25
T_4-Biovita@0.6%	100.00	112.33	65.82
T_5-Recharge@0.5%	110.53	125.17	57.00
T_6-Recharge@0.6%	107.66	119.18	60.33
T_7-Spic cytozyme@0.2%	111.13	136.86	54.13
T_8-Spic cytozyme@0.4%	109.66	134.62	56.74
T_9-Vipul@0.2%	119.26	132.19	51.56
T_{10}-Vipul@0.4%	117.14	131.74	53.79
T_{11}-Boron@0.1%	120.59	134.84	53.04
T_{12}-Boron@0.2%	115.12	132.25	54.16
T_{13}-Control	117.66	138.92	46.44
SEm ±	3.55	4.00	1.68
CD @ 0.05	10.36	11.68	4.90

Table 3: Effect of biostimulants on yield parameters of chrysanthemum cv. kolar local under fan and pad greenhouse

Treatments	Number of flowers per plant	Flower yield per plant (g)	Flower yield per m^2	Flower yield per hectare (t)	Sucker yield per plant (no.)
T_1-Humic Acid@0.5%	80.63	462.67	4.84	46.47	8.77
T_2-Humic Acida@0.6%	84.02	468.00	4.91	48.97	9.19
T_3-Biovita@0.5%	92.75	505.67	5.06	50.60	9.33
T_4-Biovita@0.6%	95.57	511.93	5.63	56.30	9.99
T_5-Recharge@0.5%	82.04	496.33	4.90	49.00	9.03
T_6-Recharge@0.6%	87.09	497.66	4.92	49.17	9.25
T_7-Spic cytozyme@0.2%	85.14	469.33	4.65	48.43	6.21
T_8-Spic cytozyme@0.4%	86.39	469.59	4.90	49.10	7.73
T_9-Vipul@0.2%	75.47	463.99	4.54	45.40	5.93
T_{10}-Vipul@0.4%	77.24	464.00	4.72	47.23	5.20
T_{11}-Boron@0.1%	71.66	449.67	4.50	44.97	6.40
T_{12}-Boron@0.2%	74.04	455.00	4.73	47.30	7.30
T_{13}-Control	55.29	419.00	4.15	41.50	4.47
SEm ±	2.64	14.33	0.18	1.97	0.36
CD @ 0.05	7.72	41.82	0.53	5.75	1.05

4. Conclusion

Increase in flower production both qualitatively and quantitatively are the important objectives to be reckoned in commercial flower cultivation. As overall result, the use of biostimulants affected the parameters positively and this effect is important during the flower cultivation. Thus, the biostimulants can be applied in minute quantities in flower cultivation without any harmful impact on environment.

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